

Monitoring and Evaluation of Loktak Lake Management Project (Wetland Ecology Component)

Report submitted to the Water Institute, Karunya University

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Principal Scientist

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CONTENTS

| | Page |
|--|------|
| Background | 1 |
| Monitoring, Evaluation Process | 1 |
| About Loktak Lake | 2 |
| Objectives of the study (water bird monitoring) | 3 |
| Methods followed | 3 |
| Results Reported by the Research Team | 4 |
| Water Bird Monitoring | 4 |
| Capacity building for park/wetland management | 13 |
| Future Plan | 16 |
| Observations and comments on physical progress | 17 |
| Financial progress in terms of cost-effectiveness & quality of results | 18 |
| Suggestions & Recommendations | 18 |
| Scientific Aspects | 18 |
| Management Aspects | 21 |
| Appendix 1 List of Plants of Loktak Lake | 25 |
| Appendix 2 List of Fishes of Loktak Lake | 30 |
| Appendix 3 List of Mammals of Loktak Lake | 32 |

BACKGROUND

The Water Institute, Karunya University signed a Technical Service Contract on 20 November 2010 with the Salim Ali Centre for Ornithology and Natural History to evaluate the Wetland Ecology component of the project, Monitoring and Evaluation of Loktak Lake Management being implemented by the Loktak Development Authority, Manipur. The proposed monitoring and evaluation is to be carried out at the Tier (III) level as laid out in the Monitoring and Evaluation Framework prepared by Wetlands International-South Asia. Further discussions were held with the Karunya University Team and the following works were deliberated upon to SACON, as project monitoring and evaluation activity.

- » Assess the status of water bird monitoring studies being undertaken by Forest Department-wildlife wing, Manipur
- » Prepare the monitoring, evaluation report

MONITORING, EVALUATION PROCESSES

The project evaluation work constituted field visits to Loktak Lake, discussion with the various stakeholders of the project and report preparation. A field visit was made to Manipur during the 3-4th week of December 2010.

Discussion with the Project Director, LDA to get an overview of the project

Discussions with the forest officials of the Wildlife Wing, Manipur and the project investigators

Field visits to Loktak Lake

Interactive meetings with local villagers, particularly fishermen and NGO members.

Verification of the project reports and field data

Preparation of monitoring, evaluation report

ABOUT LOKTAK LAKE

The study area, Loktak Lake is the largest freshwater lake in north-eastern India, also called the only Floating Lake in the world due to the floating *phumdis*. *Phumdis* are heterogeneous mass of vegetation, soil, and organic matters at various stages of decomposition. It is situated 38 km south of Imphal city (between 93°46'-93°55' E longitude and 24°25'- 24°42' N latitude) in Manipur state. The Keibul Lamjao National Park, which is the last natural refuge of the endangered Sangai or The Manipur Brow-antlered Deer (*Rucervus eldi eldi*), one of three subspecies of Eld's Deer, covering an area of 40 km², is situated in the south-eastern shores of this lake and is the largest of all the *phumdis* in the lake. Loktak and associated wetlands cover an area of 469 sq km and it is a home to thousands of resident and migratory water birds.

This ancient lake plays an important role in the economy of Manipur. It serves as a source of water for hydropower generation, irrigation and drinking water supply. The lake is also a source of livelihood for the rural fishermen who live in the surrounding areas and on *phumdis*. Human activity has led to severe pressure on the lake ecosystem. Considering the ecological status and its biodiversity values, the lake was initially designated as a wetland of international importance under the Ramsar Convention on March 23, 1990. But the lake was designated by the Ramsar Convention under the Montreux Record on June 16, 1993 for the reason that changes in ecological character have occurred, are occurring.

Construction of Ithai barrage has drastically affected fish migration thereby impacting fishing practices. *Phumdis* have profusely proliferated in the lake from 30% of lake area in 1983 to 74% in 2002 mainly due to construction of barrage. Developmental activities have led to shrinkage of wetland area, changes in biodiversity and loss of socioeconomic benefits derived by virtue of their natural functioning.

PLATE 1



Phumdi removal progressing at Loktak Lake

OBJECTIVES OF THE STUDY (As envisaged in STAP)

The Biodiversity Conservation component of the project has two major goals,
i. water bird conservation and ii. capacity building for park management.

Objectives of the water bird conservation and wetland related study are the following.

- ✓ Assessment of species composition and population estimates of waterfowl
- ✓ Assessment of species distribution and relationship with Lake environment
- ✓ Documentation of feeding, foraging and habitat relationships of critical species
- ✓ Study on Bird Migration through ringing and radio-telemetry

METHODS FOLLOWED BY RESEARCH TEAM

A census programme was conducted in the early morning of 21st January 2010 in the selected sites of Loktak Lake. Simultaneous bird count was done by forming different groups for each of the classified zones, namely northern, southern and central zone.

The zones have been demarcated with the help of GPS and satellite map.

The co-ordinates, altitude, temperature and weather conditions have been noted down including vegetation and description of the site features by using GPS and the data were entered in the Asian Waterfowl Census form.

Various forms of human interventions in and around the study sites were noted.

The waterfowl species were counted following Total Count Method.

The waterfowl species were identified with the help of the *Hand Book of Indian Birds* by Salim Ali and *Birds of Indian Subcontinent* by Richard Grimmet.

All the bird species were photographed by using telephoto and handy cam.

RESULTS REPORTED BY THE RESEARCH TEAM

Component I. Water Bird Monitoring

Objective 1. Assessment of species composition and population estimates of waterfowl

Work Envisaged in STAP

Water birds represent an integrative indicator of state of ecosystem health. Within the Short Term Action Plan (STAP), the priority would be therefore to monitor their status to support implementation of action plan for water bird conservation. The following activities are proposed to be undertaken.

Objective 1. Assessment of bird species composition and population estimates

Several field visits would be made to the lake in different seasons in order to study the species composition and their population densities. Number of field visits would be made to cover all the seasons in order to include migratory, local migratory, resident and breeding birds in the lake environment. During each field trip to the lake, a list of birds observed on day to day basis would be compiled and a comprehensive list of bird species occurring in Loktak Lake would be prepared. However, the population estimates would be carried out laying transects in various habitats, point counts at important locations and “mist netting” methods.

Physical Progress: Progress Reported by the Implementing agency-the Manipur Forest department-wildlife wing.

Avifauna composition

During the present study 39 different species of birds belonging to 12 families has been recorded in the Loktak wetland (Table 1). Anatidae represented by 17 species formed the largest family followed by Ardeidae (9 species) and Rallidae 5 species). Out of the 39 species, 22 species are resident birds and 17 are migratory birds. A near-threatened (IUCN) species, Ferruginous Pochard (*Aythya nyroca*) has

also been recorded here. A total of 24 water bird species including the Spot bill Duck and Cotton Teal breeds in this lake. Other important breeding birds include Lesser Whistling Duck (*Dendrocygna javanica*), Comb Duck (*Sarkidiornis melanotos*) and Large Whistling Duck.

Table 1 List of birds recorded in Loktak Lake (IUCN status NT=Near-threatened, LC= Least Concern) ; Breeding Status in Loktak Lake, B= Breeding, NB= Not breeding)

| Sl. No | Common Name | Scientific Name | Family | Local Name | Resident/ Migrant | IUCN Status | # of birds counted | % proportion | Breeding status |
|--------|---------------------|----------------------------|--------------|--------------|-------------------|-------------|--------------------|--------------|-----------------|
| 1 | Purple Moorhen | <i>Porphyrio porphyrio</i> | Rallidae | Umu | R | LC | 163 | 2.8 | B |
| 2 | Grey Heron | <i>Ardea cinerea</i> | Ardeidae | Ushai | R | LC | 46 | 0.79 | B |
| 3 | Great Egret | <i>Casmerodius albus</i> | Ardeidae | Urok | R | LC | 23 | 0.39 | B |
| 4 | Little Egret | <i>Egretta garzetta</i> | Ardeidae | Urok | R | LC | 47 | 0.81 | B |
| 5 | Grey-headed Lapwing | <i>Vanellus cinereus</i> | Charadriidae | Salangkak | M | LC | 24 | 0.41 | NB |
| 6 | Indian Pond Heron | <i>Ardeola grayii</i> | Ardeidae | Urok lamprai | R | LC | 44 | 0.76 | B |
| 7 | Common Moorhen | <i>Gallinula chloropus</i> | Rallidae | Pat-men | R | LC | 26 | 0.45 | B |
| 8 | Water Cock | <i>Gallicrex cinerea</i> | Rallidae | Uthum | R | LC | 13 | 0.22 | B |
| 9 | Purple Heron | <i>Ardea purpurea</i> | Ardeidae | Ushai | R | LC | 5 | 0.08 | B |

| | | | | | | | | | |
|----|-------------------------------------|----------------------------------|-------------------|-----------------------|---|-------|------|-----------|----|
| 10 | Coot | <i>Fulica atra</i> | Rallidae | Nganu porom | M | LC | 540 | 9.38 | NB |
| 11 | Northern Shoveler | <i>Anas clypeata</i> | Anatidae | Nganu khara | M | LC | 23 | 0.39 | NB |
| 12 | Common Teal | <i>Anas creca creca</i> | Anatidae | Nganu surit | M | LC | 1000 | 17.3 7 | NB |
| 13 | Little Grebe | <i>Tachybatus ruficollis</i> | Podicipedi dae | Uthit | M | LC | 14 | 0.24 | N |
| 14 | Northern Pintail | <i>Anas acuta</i> | Anatidae | Meitunga | M | LC | 06 | 0.10 | NB |
| 15 | Gadwall | <i>Anas strepera</i> | Anatidae | Thoiding num | M | LC | 434 | 7.53 | NI |
| 16 | Lesser Whistling Duck | <i>Dendrocygna javanica</i> | Anatidae | Tingi | R | LC | 2640 | 45.8 6 | |
| 17 | Brahminy Shelduck | <i>Tadorna ferruginea</i> | Anatidae | Thangong | M | LC | 82 | 1.42 | |
| 18 | Large whistling Duck | <i>Dendrocygna bicolor</i> | Anatidae | Tingi achouba | R | Sch-1 | 2 | 0.03 | |
| 19 | Asian Open-bill Stork | <i>Anastomus oscitans</i> | Anatidae | Tharoi chabi | R | LC | 13 | 0.22 | |
| 20 | Common Pochard | <i>Aythya ferina</i> | Anatidae | Irupi | M | LC | 13 | 0.22 | |
| 21 | Median Egret | <i>Egretta intermedia</i> | Ardeidae | Langkhon g sang | R | LC | 19 | 0.33 | |
| 22 | Black- crowned Night Heron | <i>Nycticorax nycticorax</i> | Ardeidae | Chongkhu | R | LC | 5 | 0.08 | |

| | | | | | | | | | |
|----|---------------------------------|--|------------------------|------------------|---|----|-----|-----------|----|
| 23 | Cattle Egret | <i>Bubulcus ibis</i> | Ardeidae | Sandungin | R | LC | 212 | 3.68 | B |
| 24 | Red crested Pochard | <i>Netta rufina</i> | Anatidae | Iruppi | M | LC | 3 | 0.05 | NB |
| 25 | Spotbill Duck | <i>Anas poecilorhyn- cha</i> | Anatidae | Nganu peren | M | LC | 2 | 0.03 | B |
| 26 | Great Cormorant | <i>Phalacrocora x carbo</i> | Phalacro- coracidae | Ura | M | LC | 33 | 0.57 | NB |
| 27 | Cotton Teal | <i>Nettapus coromandel- ia</i> | Anatidae | Nganu pedagot | M | LC | 7 | 0.12 | B |
| 28 | Comb Duck | <i>Sarkidiornis melanotos</i> | Anatidae | Samchet Nganu | R | LC | 1 | 0.01 % | B |
| 29 | Pheasant- tailed Jacana | <i>Hydrophas- ia nus chirurgus</i> | Jacanidae | Thamna chenbi | R | LC | 54 | 0.93 | B |
| 30 | Bronze- winged Jacana | <i>Metopidius indicus</i> | Jacanidae | Yen paoraba | R | LC | 18 | 0.31 | B |
| 31 | White- breasted Water Hen | <i>Amaurornis phoenicurus</i> | Rallidae | Urenkotho ng | R | LC | 16 | 0.27 | B |
| 32 | Yellow Bittern | <i>Ixobrychus sinensis</i> | Ardeidae | Hongai | R | LC | 34 | 0.59 | B |
| 33 | Red-wattled Lapwing | <i>Vanellus indicus</i> | Charadriid ae | Salangkak | R | LC | 23 | 0.39 | B |
| 34 | Little Ringed Plover | <i>Charadrius dubius</i> | Charadriid ae | - | M | LC | 37 | 0.64 | NB |
| 35 | Common Snipe | <i>Gallinago gallinago</i> | Charadriid ae | - | M | LC | 20 | 0.34 | NB |

| | | | | | | | | | |
|----|---------------------------|---------------------------|-------------|-----------------|---|----|----|------|----|
| 36 | White-breasted Kingfisher | <i>Halcyon smyrnensis</i> | Alcedinidae | Ngarakpi | R | LC | 6 | 0.10 | B |
| 37 | Three-toed Kingfisher | <i>Ceyx erithacus</i> | Alcedinidae | Ngarakpi macha | R | LC | 8 | 0.13 | B |
| 38 | Ferruginous Pochard | <i>Aythya nyroca</i> | Anatidae | Nganu mitngoubi | M | NT | 34 | 0.59 | NB |
| 39 | Garganey Duck | <i>Anas querquedula</i> | Anatidae | Surit angouba | M | LC | 23 | 0.39 | NB |

Objective 2. Assessment of species distribution and relationship with Lake Environment

Work Envisaged in STAP

The relationship of birds with the lake environment is an important component of the study. The relationship of birds with its environment is determined by the bird's morphological structure and behavioural function, its ability to obtain food and shelter successfully, which affects the survival of the species. While surveying the birds, upon sighting of each species or a group of species, coordinates would be recorded using GPS. The data on the lake environment would also be collected simultaneously which include the habitat type, microhabitat type, food plant species, food availability, depth of water, height of the vegetation etc. The data on the Lake Environment and coordinates would be plotted on available habitat map of the lake and will be cross analyzed and tested for correlations to reveal any significant relationships between them. The statistical correlations would be derived between the uses of habitats by particular species and the environmental parameters of the lake.

Progress Reported

Major Bird Congregation Sites

The project investigators have identified several important bird congregation sites within the Lake. Birds sighted during the study have been listed. Birahari Pat in

Northern Zone, Phubala and Chingnungsoi in central zone Keibul Lamjao National Park and Khordak/Nongmaikhong in southern Zone were found to be important bird congregation sites.

Birahari Pat

It covers Toubul, Nachou, Potsangbam, Upokpi, Toupokpi and some parts of Ningthoukhong in Bishnupur district. The area is a major congregation site of wintering migratory and resident water birds like Common teal, Lesser Whistling Duck, Gadwall, Little Grebe, Coot etc.

Phubala

Phubala Tourist Home is some 36 kilometers away from Imphal and it is the richest home of the Purple Moorhen (*Porphyrio Porphyrio*) locally known as *Umu*. The reason why this particular resident bird had chosen this site as their natural habitat is the prevention of poaching by BSF personnel stationed in the tourist home.

Chingnungsoi, Moirang

Chingnungsoi covering Thamnapokpi is a private fish farming area. The area is the richest habitat of Lesser Whistling Duck and other species such as Comb duck, Common Indian Moorhen, Jacana, and Purple Heron.

Adjoining locations of Keibul Lamjao National Park

The area adjoining the KLNP is the richest congregation site of migratory and resident birds of Loktak Lake. Important birds observed include Brahminy Duck, Open-bill Stork, Purple heron, Cormorants, Pintail, Gadwall, Little Grebe and pochards. The formation of richest congregation in the park area is due to human pressure at the other parts of Loktak Lake. Probably birds find this place as a safe shelter as it is a marginal area of the protected area.

Khordak/Nongmaikhong

This location is also a major congregation site. Most of the areas of this site are used by private fishing farm. Important species recorded include Cotton teal, Gadwall, Lesser whistling Duck, Brahminy Duck, Open-bill Stork, Common Moorhen and Pond Heron.

Seasonality of Birds

A large congregation of birds was seen in Loktak Lake during winter. Migratory birds started arriving during last week of September and stayed up to the last week of March. Breeding season started in April and extended up to early August. Spot-bill duck stayed for a longest duration. This species breeds in Loktak Lake. Least population of birds was seen during August and September. Further study is planned for documenting the seasonality of birds in Loktak.

Objective 3. Documentation of feeding, foraging and habitat relationships of critical species

Work Envisaged in STAP

Detailed understanding of the food and foraging in relation to the habitat is of utmost importance especially for the critical species of the ecosystem. Different species of waterfowl has differential food and foraging habitat requirements. The food for waterfowl ranges from aquatic macrophytes and invertebrates. The preliminary surveys would help assess the status of the critical species in the Loktak Lake. The survey may help to identify the bird species that are keystone species, indicator species or flagship species of the lake environment. Such species surviving in and around Lake Environment would be studied in detail in order to understand their feeding, foraging and habitat requirements. These critical species would be followed and specific observations would be made on each of the species and data would be collected using focal animal sampling method. The data on availability of the food species and their use would be cross analyzed and tested to reveal the significance of their relationship in the lake environment.

Progress Reported

Feeding and Foraging Ecology

Based on their feeding ecology, water birds of Loktak Lake can be categorized into three types namely, piscivores, benthivores and plantivores (herbivores). Since the last category that mainly included the ducks also consume benthic invertebrates, only two major guilds have been considered i.e. piscivores and benthivores. The benthivores comprising primarily waders and ducks contributed the majority of the water bird population. Water bird population and densities increased concomitantly with that of the total benthic invertebrates-nematodes, polychaetes, crustaceans and molluscs. Birds utilized the wetland primarily as a foraging ground.

Objective 4: Bird Migration studies through ringing and radio-telemetry

Work Envisaged in STAP

Some of the critical species which are migrating to the lake environment would be studied using ringing or banding methods. Based on our avifauna survey results, the species and their number to be ringed for migration study would be decided. A standard bird ringing methodology practiced by international bodies would be used by taking support and guidance from Bombay Natural History Society (BNHS). The ringed or banded birds would be monitored using a network of volunteers and birdwatchers and forest staff in the area. In case of some bird species, the option of using radio-telemetry would be explored. The study using radio telemetry would provide continuous data on migration route and the habitats used by the species enroute.

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Progress reported

Bird migration study, particularly ringing and radio telemetry have not been undertaken so far. Under capacity building, forest department staff and volunteers were given training in bird ringing and radio telemetry studies by the Bombay Natural History Society. As a part of the ongoing research, radio telemetry and ringing of migratory birds will be started from January-February, 2011 with the technical assistance of the Bombay Natural History Society.

Anthropogenic disturbances

Major anthropogenic activities which altered and changed the habitat of the water birds in Loktak wetland started since the early part of 1970. The commissioning of Ithai Barrage of National Hydro Electric Project in Loktak Lake brought major changes in the Lake environment. The natural wetland has been made into an artificial impoundment of water. As the level of the water rose, the availability of the food declined in an unprecedented way leading to the dwindling of the number of species and population of water birds in Loktak. Number of submerged plants which anchor in the floor like *Trapa natans* could not grow any more as the level of the rose.

Before the commissioning of Ithai Barrage, there was a natural process of cleaning the sediments and silts brought down by the feeding rivers from the Loktak through Khordak reaching Chindwin river of Myanmar. But the presence of the barrage at Khordak outlet blocks this process and cleaning of proliferating *Phumdi* and movement of the migratory fishes. The State fish of Manipur, *Osteobrama belangeri* locally known as Pengba, a migratory fish has never return to this lake due to the barrage.

The other crucial anthropogenic activities are:

Indiscriminate deforestation at the river head and catchments of the lake lead to heavy siltation in the lake. It has been reported that fifty percent of the top soil is lost (600000 tons, WAPCOS) annually in the catchments has been retained in the bed of the lake as the lake act as a sediment trap of the silts brought down by the feeding rivers and streams.

The heavy pressure and encroachment of the phum dwelling fisherman and their fishing activities in the habitat of the water birds including trapping, poaching and usage of different kinds of toxic insecticides and pesticides.

Surface run-off of the chemical pesticides and insecticides of the agricultural crop lands brought down by the feeding rivers and untreated municipal and town sewage draining directly into the lake thereby polluting wetland ecosystem.

PLATE 2



Fish collection in a *athaphum*



Fishing: a major source of income for the local community

Another major problem is shrinking of area of the lake due to human settlement and encroachment and compartmentalization of the area for various development projects.

Increasing population of fishing phum dwellers and their activities in the Lake is a major habitat disturbance.

Dumping of thousands of heavy stones for anchoring the floating huts and floating ring fishing cage by fishermen affects water flow.

In addition to birds, plants, fishes and mammals recorded in the Loktak Lake are listed and given in Appendices, I, 2 and 3 respectively.

Component II. Capacity Building for Park/Wetland Management

Programme envisaged in STAP

Conservation and management of KLNK essentially involves protection of wildlife, habitat improvement of the park and reducing pressures by providing alternate income generation opportunities to the people around the park. The solutions for long-term management have to be based on scientific management involving local communities at all levels. Currently the park managers are trained in traditional wildlife management with the focus on protection of flagship species without taking into consideration of habitat characteristics that are governed by complex hydrological processes. The capacity of the park managers has to be built up to meet these challenges. For capacity building specific training programmes on integration of hydrological aspects into wildlife management, techniques of maintaining the vegetation for threatened wildlife and improving habitat by interventions based on ecological principles. The infrastructure for analysis of habitat features and wildlife management needs to be built up on priority basis.

Summary activities proposed for strengthening the capacity of KLNK management include: 10 specialized training programs for different level, Purchase of 3 vehicles, Purchase of 2 motor cycles for Range officers, Purchase of 15 dug out

canoes and boats, Purchase of computer systems including workstations, Pentium4, printer, plotter, scanner, digitiser, (GIS and Image Processing Software) Outfit for staff (WTI package)

Progress Reported

Infrastructure Development

As a part of infrastructure development, purchase of 1 four wheeler (TATA), 2 motor bikes, 15 canoes, Computer (Desktop, Laptop), LCD projector, and cameras are reported by the Forest Department.

Capacity Building and Training

The following training/awareness programmes are reported to be conducted by the Forest Department. This included both capacity building and awareness creation for wetland conservation.

One day training programme on bird identification and census technique was conducted at Phubala Makha Leikai community hall in association with Gandhi Memorial Club, Phubala on the 25th January 2010. Shri H. Pravash Singh, Dr. Kh. Shamungou, R.K. Birjit Singh and K.Jugeshor Singh presented power point presentation regarding bird identification and different techniques of bird census. Eighty delegates participated in the programme.

A 2-Day Mid-Winter Water Bird Census motivation camp was organized at Keibul Lamjao National Park from 14 to 15th December 2010 for enabling the members of the different organizations to join the census programme which is to be conducted in the 2nd week of January, 2011. Dr. Kh. Shamungou Singh, K.Jugeshor Singh and R.K. Birjit Singh trained the 60 participants on the techniques of counting, identification of water birds, use of GPS and other instruments.

5-Days special training (1st June to 5th June, 2010) was imparted to the officials of the Forest Department, Wild Life Wing, Loktak Development Authority

PLATE 3



Phumdi formation: early succession stage



Phumdi in climax stage that forms the habitat for Manipur Brow- antlered Deer

(LDA) and researchers on water bird identification and population monitoring, ringing and radio telemetry studies, bird trapping using nets in collaboration with the Bombay Natural History Society and Indian Bird Conservation Network. It was coordinated by Dr. S. Balachandran of the Bombay Natural History Society.

Awareness programme

One day awareness cum capacity building programme was organized on 2nd February, 2010 on one of the floating huts of Birahari Pat in commemoration of the World Wetland Day. 60 *phum* dwelling fisherman participated in the programme. Dr. Kh. Shamungou, K. Jugeshor Singh, R.K. Birjit Singh and Dr. Kh. Gajanada Singh stressed on the judicious use of biological resources of Loktak wetland, as their future depend on the fate of Loktak.

A One day awareness campaign was organized at Khordak- Nongmaikhong area on the 16th February, 2010 with Shri T. Budhi Singh, President, Sangai protection Forum in the Chair. Shri L. Joykumar Singh, DCF, Park and Sanctuary, Department of Forest, Wild Life, Wing and Kh. Hitler Singh, R.O., Keibul Lamjao deliberated on the topic, " Loktak Wetland, the Life line of Manipur.

A One day media- sensitization programme was conducted at Keibul Lamjao National Park (KLNP) on 14th March, 2010 for sensitizing the media (print and electronic) for the conservation of Loktak wetland and the importance and conservation of water birds. Dr. R.K. Ranjan Singh, Director, Academic Staff College, Manipur University, State Coordinator, IBCN, Dr. Kh. Shamungou and Salam Rajesh Singh, Senior Journalist deliberated on the role of media in promoting conservation of Loktak wetland.

One day awareness cum capacity building camp was held on 11th January, 2010 at Ishok in collaboration with the Universal Club, Ishok on the role of voluntary organizations in Loktak wetland conservation. Dr. Kh. Shamungou, R.K. Birjit Singh and K. Jugeshor Singh made presentations on the conservation of water birds in Loktak wetland and the role of voluntary organizations in protection and conservation.

FUTURE PLAN

Formation of Site Support Group (SSG) in and around the lake areas. SSG volunteers in partnership with other stakeholders of the lake would help promote conservation and sustainable development of Loktak Lake, particularly water birds and other key biodiversity components.

Establishing self sustaining network of voluntary organizations, who would work with the Forest Department and Loktak Development Authority, to link the local communities.

Identify the threats such as agricultural expansion, human settlement, encroachment and over-exploitation of resources, pollution etc.

Monitor the bird population, study species composition and the habitat features from at least eight different study locations in Loktak.

Conduct mid-winter water bird census in concurrence with the norms of Asian Waterfowl Count (AWC) in collaboration with Bombay Natural History Society (BNHS) and IBCN.

Identify the routes of the different migratory bird species wintering in Loktak through radio telemetry and ringing.

Establish bird-watching groups and eco-clubs.

Construct a floating bird study station in Loktak Lake.

Conduct mass awareness campaign to students of various schools and colleges located in and around the lake.

Make a check-list of water birds, plants, fishes and other faunal species in the lake.

OBSERVATIONS AND COMMENTS ON PHYSICAL PROGRESS

A. Wetland Ecology: Water bird Monitoring

Objective 1: Assessment of species composition and population estimates of waterfowl:

Progress noted. 39 bird species are reported from the lake. Several more bird species are likely to use this wetland as a wintering ground. More efforts need to be made during the forthcoming season.

Objective 2. Assessment of species distribution and relationship with Lake Environment:

Progress noted. Important bird congregation sites were located. Bird species sighted in these locations have been recorded. Data on habitat features of these locations are not enough.

Objective 3. Documentation of feeding, foraging and habitat relationships of critical species

Very little progress made.

Objective 4. Study on Bird Migration through Bird ringing and Radio-telemetry.

With the involvement of Bombay Natural History Society's Bird banding Team, a training/workshop on water bird studies including bird ringing and radio telemetry was organized by the Forest Department's wildlife wing at Imphal. The staff and volunteers were trained in the aforementioned works. However, further work on bird ringing has not yet been initiated by the forest department.

B. Capacity building and training

Satisfactory progress has been made in Infrastructure Development, Capacity building and Training component of the project.

FINANCIAL PROGRESS IN TERMS OF COST-EFFECTIVENESS AND QUALITY OF RESULTS

It has been reported by the forest department-wildlife wing, Manipur that the grant received from the Loktak Development Authority has been fully spent to achieve the targets of a). water bird monitoring programme b). Infrastructure development, capacity building and training.

Substantial progress has been reported in terms of infrastructure development. Vehicles, computers, LCD projector and cameras have been purchased.

With regard to the progress in water bird monitoring study is concerned, the quantum of data gathered is not sufficient. The quality of results needs lot of improvement.

SUGGESTIONS & RECOMMENDATIONS FOR ENHANCING EFFECTIVENESS OF PROJECT IMPLEMENTATION

Scientific Aspects

Formation of a Core Research Team

Substantial progress in terms of research work on water bird monitoring is the need of the hour. Investigators involved in the program are involved on part-time basis only. They are the right persons, competent to do this job. Due to lack of adequate supporting staff (research scholars) they are unable to collect adequate data on various parameters that are essential for the project. A lot of manpower is required to achieve the results. It is strongly recommended to employ 3-4 research scholars who could be paid from the project funds, within the available budget. A core research team comprising the DCF wildlife, project investigators and newly recruited research scholars could make a work plan for each objective (total 4 objectives) before initiating the next year's field work.

Habitat-wise data collection

Study locations should be grouped under major micro-habitat categories observed in the Lake. Lake has various micro-habitats namely, sedge-dominated marshy landscape ii. Shallow water with *phumdis* in early succession stage (dominated by floating species) iii. Deep water with submerged vegetation and iv. *phumdis* in climax stage (Phragmites dominated). Different types of bird species are found to be using these habitats. While moorhens and some waders prefer sedge dominated habitats, cormorants and other fish eaters prefer deep water habitats. Study should be done in all the above-mentioned habitats.

Systematic sampling of various parameters is suggested. This includes monthly sampling of various parameters throughout the remaining study period. In all the habitats, physical, physicochemical and biological parameters need to be gathered. Parameters that are very essential include, water depth, pH, bird species and their abundance, vegetation features such as species composition of macrophytes, abundance or biomass, quantification of food organisms such as macro-invertebrates and human activities such as fishing, vegetation removal etc.

Food and Foraging habits

Food items of various avian guilds such as fish eating birds, plantivores and omnivores have to be estimated. Scan sampling method can be followed to document the items consumed. Macro-invertebrates, particularly insects and molluscs of the aquatic ecosystems play a major role in the habitat preference of different waterfowl species. Hence major emphasis should be given to estimate their abundance. Estimation of fish availability during different seasons could help in relating the seasonal variations in the abundance of fish eating birds.

Impact of *phumdi* removal on bird population

Bird abundance in human impacted habitats such as fish farms, *phumdi* removal sites and undisturbed sites (relatively less disturbed) could be collected. The data will help to assess the impact of human activities on bird population within the Lake.

Identification of breeding locations of birds

Major bird breeding locations within the Loktak Lake have to be located. Data on species breeding in Loktak Lake have to be generated. Vegetation/plants used as nesting substratum or nesting purpose could be recorded. Anthropogenic disturbances in the breeding sites have to be recorded and certain suggestions can be made to the forest department to minimize human activities in breeding sites.

Bird Migration Study

Bird migration studies need to be initiated at the earliest. So far, under capacity building and training, personnel have been trained in bird ringing, radio-telemetry and migration studies. Projected work on this line includes bird ringing and radio-telemetry. Materials such as rings, mist nets, pesola balances required for the ringing study should be mobilised first. While metal rings of various sizes could be procured from the Bombay Natural History Society, mist nets (import) could be bought from concerned manufactures. Bird ringing data must be entered in appropriate formats, specially designed by BNHS. In order to avoid injury to birds, trained bird trappers should be involved in bird catching. To complete the work, two options are possible. i. involving the BNHS bird banding team, ii. a local team comprising the investigators already involved in this research work can be assigned to do this work. If the BNHS bird trappers are not available for this work due to their preoccupations, some local bird catchers (traditional) can be engaged by the forest department. Those people can be briefed about the need for bird conservation and not to hunt birds.

Preparation of Checklist of birds

Check-list of birds, fishes and flora of the lake could be prepared. In addition to water birds, number of other birds namely birds of prey, granivores etc are seen in the lake area. The bird checklist could include all the species in the lake environment.

PLATE 4



Floating huts in the Loktak Lake

PLATE 5



Sedge-dominated marshy habitat in Loktak Lake



Field visit to Loktak Lake and interaction with the project investigators

Manpower allotment

Research scholars with post-graduate degrees in botany/zoology/environmental science and related subjects must be employed in this project on fulltime basis, in order to collect voluminous data that is essential to fulfil the objectives of this project. They should collect data on various ecological parameters on a regular basis, almost in all the months. This must be done on a priority basis. Employing one research scholar per objective could be a better option.

Management Aspects

Biodiversity Conservation

As anthropogenic disturbances such as fishing, cultivation and poaching are prevalent in the lake area, declaration of certain important bird congregation sites as Community Reserve and Conservation Reserve could be attempted. While sites in the possession of government of Manipur can be declared as Conservation Reserves, areas in private peoples' custody are suitable for declaration of Community Reserves.

Some potential sites for conservation reserves are, i. Phubala, ii. Chingnungsoi, iii. Thrangbelyangbi, iv. Thamnapokpi, v. Ibohal Farm, vi. Tangjeng Lake, vii. Nongmaikhong, viii. Laphupat, ix. Ishok Pumlen Pat, x. Khoidum Pat, xi. Phabakchao and xii. Kumbi Pat. Precise locations and the extent of area etc could be decided by the Forest Department-Wildlife Wing.

The declaration of some identified locations in the Lake as Conservation Reserve would enhance the protection measures of the Forest Department. Poaching activities could be brought under control by enforcing relevant laws against the offenders. Declaration of Community Conservation Reserves and subsequent awareness education programs for the local communities is likely to yield fruitful results in terms of avifauna conservation. Existing NGO network could be effectively used for sensitization of conservation awareness.

Eco-tourism

The Conservation Reserves could also be eco-tourism sites, as watching bird congregations in the Lake would be an aesthetic experience for animal lovers. Students, general public of the state and tourists from other parts of the country could be the potential visitors. Entrance fee could be charged from the visitors, which would fetch income for the management of the conservation sites. Phubala is one such location, where birds can be observed in close quarters.

Nature conservation Awareness

Nature conservation awareness programmes are the need of the hour. It appears any bird seen in the vicinity of the local communities is trapped and eaten. Local communities must be educated on nature conservation and role of birds in ecosystem maintenance etc. Birds using this wetland are disturbed by two ways, i. fishing activities of local people, ii. poaching. If poaching activities are controlled, the resident waterfowl would use this lake as a breeding ground. To create nature conservation awareness, programs could be organized in various parts of the neighbouring villages by involving college teachers as resource persons. The already existing local conservation NGO's could mobilize the local people and the forest department can be the coordinator of the event. Before initiating the awareness program, one day field tour (a trip by boat) to the Lake and briefing of the Loktak Development Programme could be done to the teachers (resource persons) themselves.

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Appendix 1. List of the plants of Loktak Lake

(Source: Shamungou et al 2010)

| Sl.No | Family | Botanical Name | Local Name |
|-------|------------|---------------------------------|--------------------------|
| 1 | Poaceae | <i>Arundo donax</i> | Luwang tou |
| 2 | | <i>Andropogon zizanoides</i> | Tumnou |
| 3 | | <i>Brachiaria mutica</i> | Paragrass |
| 4 | | <i>Cymbopogon natus</i> | Charot |
| 5 | | <i>Coix lacryma jobi</i> | Chaning |
| 6 | | <i>Echinochloa stegnina</i> | Hup |
| 7 | | <i>Erianthus arundinaceus</i> | Singmut |
| 8 | | <i>Erianthus procerus</i> | Singnang |
| 9 | | <i>Imperata cylindrica</i> | Ee |
| 10 | | <i>Coix lacryma</i> | Yawa chaning |
| 11 | | <i>Echinochloa sp</i> | Hupkha |
| 12 | | <i>Echinochloa colonum</i> | Urichak |
| 13 | | <i>Echinochloa crusgalli</i> | Urichak manbi |
| 14 | | <i>Cynodon dactylon</i> | Tingthou |
| 15 | | <i>Dactyloctenium aegyptium</i> | Napi porom |
| 16 | | <i>Capillipedium sp.</i> | Wanamambi |
| 17 | | <i>Panicum humidorum</i> | Kangmapal |
| 18 | | <i>Phragmites karka</i> | Tou/Tourel |
| 19 | | <i>Oryza rufipogon</i> | Wainu chara (Wild Rice) |
| 20 | | <i>Oryza sativa</i> | Phou |
| 21 | | <i>Saccharum munja</i> | Khoimom |
| 22 | | <i>Zizania latifolia</i> | Eesing Kambong |
| 23 | | <i>Saccharum spontanium</i> | Mom |
| 24 | | <i>Setaria peltidesfusca</i> | Hup |
| 25 | | <i>Sacciolepis myosuroides</i> | Lam Hup |
| | Cyperaceae | | |
| 26 | | <i>Carex cruciata</i> | Humdang |
| 27 | | <i>Scirpus lacustris</i> | Kouna |
| 28 | | <i>Cyperus brevifolius</i> | Chumthang macha |
| 29 | | <i>Cyperus auricomus</i> | Chumthang napakpi |
| 30 | | <i>Cyperus pilosus</i> | Chumthang makhok akanba |
| 31 | | <i>Cyperus esculentus</i> | Chumthang makhok athotpa |

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|----|--------------|---|-----------------------------------|
| 32 | | <i>Cyperus sanghinalentus</i> | Chumthang makhok akoiba |
| 33 | | <i>Cyperus cephalots</i> | Chumthang makhok(Triangular) |
| 34 | | <i>Cyperus iria</i> | Chumthang makhok athotpa & akoiba |
| 35 | | <i>Cyperus umbellatus</i> | Chumthang |
| | | <i>Fuirena umbellata</i> | Lamthangjou |
| | Polygonaceae | | |
| 36 | | <i>Polygonum chinense</i> | Lilhar(Angom Yensil) |
| 37 | | <i>P. hydropiper</i> | Lilhar |
| 38 | | <i>P. barbatum</i> | Yellang |
| 39 | | <i>P. orientale</i> | Chaokhong |
| 40 | | <i>P. lapathifolia</i> | Chaokhong manba |
| 41 | | <i>P. barbatum</i> | Morokshabi |
| 42 | | <i>P. glabrum</i> | Chouhaisabi |
| 43 | | <i>Rumex maritimus</i> | Torong khongchak |
| 44 | | <i>Rumex nepalensis</i> | Torong khongchak |
| | Asteraceae | | |
| 45 | | <i>Gynura angulosa</i> | Terapaibi |
| 46 | | <i>Mikania cordata</i> | Uri-hingchabi |
| 47 | | <i>Eclipta prostrata</i> | Uchisumbal |
| 48 | | <i>Ageratum conizoides</i> | Khongjainapi |
| 49 | | <i>Galinsoga parviflora</i> | Khongjainapi manbi |
| 50 | | <i>Dichrocephala latifolia</i> | Awaphagidom manbi |
| 51 | | <i>Dichrocephala sp.</i> | Hangamula manbi |
| 52 | | <i>Gnaphalium luto album.</i> | Phunil |
| 53 | | <i>Tagetes erecta</i> | Sanarei |
| 54 | | <i>Spilanthes acmella</i> | Lalucouba |
| | Nymphaeaceae | | |
| 55 | | <i>Nelumbo nucifera var N. rubra Roxb</i> | Thambal Angangba |
| 56 | | <i>Nymphaea pubescens willd var.</i> | Thambal angouba |

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|----|----------------|---|-----------------|
| 57 | | <i>N. alba</i> <i>Roxb. Nymphoides</i> <i>indicum (Linn) O.</i> <i>Kutje</i> | Ngachak komol |
| 58 | | <i>Euryle ferox</i> | Thangjing |
| 59 | | <i>Nymphaea stellata</i> | Thariktha |
| | Cucurbitaceae | <i>Lagenaria vulgaris</i> | Koubuyai |
| 60 | | <i>Bryonopsis laciniosa</i> | Kwakthabi |
| 61 | | <i>Trichosanthus</i> <i>bracteatus</i> | Kwakthabimanbi |
| 62 | | <i>Melothria purpusilla</i> | Lamthabi |
| | Onagraceae | | |
| 63 | | <i>Ludwigia octovalvis</i> | Devo |
| 64 | | <i>L. claveliana</i> | Ishing kundo |
| 65 | | <i>Ludwigia sessiliflora</i> | Chaoradevo |
| 66 | | <i>Hedychium</i> <i>coronarium</i> | Loklei |
| 67 | | <i>Gastrochilus</i> <i>longiflora</i> | Lam-yaingang |
| | Zinziberaceae | | |
| 68 | | <i>Alpinia galanga</i> | Pullei |
| | Apiaceae | | |
| 69 | | <i>Enhydra fluctuans</i> | - |
| 70 | | <i>Oenanthe javanica</i> | Komprek |
| 71 | | <i>Centella asiatica</i> | Peruk |
| 72 | | <i>Eclipta alba</i> | Komprek tujombi |
| 73 | | <i>Eringium foetidum</i> | Awaphagidom |
| | Convolvulaceae | | |
| 74 | | <i>Argyreia nervosa</i> | Uri-tujombi |
| 75 | | <i>Ipomoea aquatica</i> | Kolamni |
| 76 | | <i>Cuscuta reflexa R</i> | - |
| | Alismataceae | | |
| 77 | | <i>Plantago alisma</i> | Kouthrum |
| 78 | | <i>Sagittaria sagittifolia</i> | Koukha |
| | Amaranthaceae | | |
| 79 | | <i>Alternanthera</i> <i>pheloxeroides</i> | Kabonapi |
| 80 | Pontederiaceae | <i>Amaranthus spinosus</i> | Chengkruk |

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|-----|------------------|--------------------------------|--------------------|
| 81 | | <i>Monochoria hastaeifolia</i> | Ngachak komol |
| 82 | | <i>Eichhornia crassipes</i> | Kabokang |
| | Solanaceae | | |
| 83 | | <i>Solanum nigrum</i> | Leipung khangga |
| 84 | | <i>Solanum khasianum</i> | shing khangga |
| | Araceae | | |
| 85 | | <i>Colocasia esculenta</i> | Lampal |
| 86 | | <i>Pistia stratiotes</i> | Kangjao |
| | Rubiaceae | | |
| 87 | | <i>Stephegyne divercifolia</i> | Chomlang |
| 88 | | <i>Anotis urophylla</i> | Namthibi |
| | Hydrocharitaceae | | |
| 89 | | <i>Vallisneria spirallis</i> | Lairenchak |
| 90 | | <i>Hydrilla sp.</i> | Charang |
| | Hydrophyllaceae | | |
| 91 | | <i>Hydrilla zeylanica</i> | Charangkokphabi |
| 92 | | <i>Hydrilla verticillata</i> | Charang kokchaobi |
| | Salviniaceae | | |
| 93 | | <i>Salvinia natans</i> | Kangkup |
| 94 | | <i>Azolla pinnata</i> | Kang-macha |
| | Malvaceae | | |
| 95 | | <i>Urena lobata</i> Linn | Sampakpi |
| 96 | | <i>Hibiscus radiatus</i> | Jubakushum manbi |
| | Mimosaceae | | |
| 97 | | <i>Mimosa pudica</i> | Kangphal Ekaithabi |
| 98 | | <i>Neptunia oleracea</i> | Tejpat-manbi |
| | Primulaceae | | |
| 99 | | <i>Primula euosma</i> | Hidakmana-manbi |
| | Verbenaceae | | |
| 100 | | <i>Callicarpa arborea</i> | Hameibol |
| | Dioscoreaceae | | |
| 101 | | <i>Dioscorea anguina</i> | Kwamana-mambi |
| | Chenopodiaceae | | |
| 102 | | <i>Chenopodium album</i> | |
| | Orchidaceae | | |
| 103 | | <i>Malaxis maximowicziana</i> | Yai-asinbi |

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|-----|------------------|--------------------------------|--------------------|
| 104 | Papilionaceae | <i>Cassia sp.</i> | Chuchuramei- manbi |
| | Commelinaceae | | |
| 105 | | <i>Commelina obliqua</i> | HamKabonapi-manbi |
| | Passifloraceae | | |
| 106 | | <i>Passiflora admophylla</i> | Uri |
| | Menispermaceae | | |
| 107 | | <i>Stephania lernandifolia</i> | Uri Heiyeenmanbi |
| | Urticaceae | | |
| 108 | | <i>Elatostema sp.</i> | - |
| | Scrophulariaceae | | |
| 109 | | <i>Torenia vagans</i> | Scrophularia |
| | Musaceae | | |
| 110 | | <i>Musa paradisiaca</i> | Laphu |
| | Geraniaceae | | |
| 111 | | <i>Iris beckeri</i> | Kombirei |

Appendix 2. List of fishes recorded in Loktak Lake

(Source: Shamungou et al 2010)

| Sl. No. | Zoological Name | Local Name |
|---------|--|-------------------|
| 1. | <i>Notopterus notopterus (Pallas)</i> | Kandla |
| 2. | <i>Hypophthalmichthys molotrix (Valenciennes)</i> | - |
| 3 | <i>Amblypharyngodon mola (Hamilton)</i> | Mukanga |
| 4 | <i>Aspidoparia morar (Hamilton)</i> | Mukanga |
| 5 | <i>Barilius barila (Hamilton)</i> | Ngawa |
| 6. | <i>Barilius barna (Hamilton)</i> | Ngawa |
| 7. | <i>Esomus danricus (Hamilton)</i> | Ngasang |
| 8. | <i>Catla catla(Hamilton)</i> | Catla |
| 9. | <i>Cirrhinus mrigala(Hamilton)</i> | Mrigal |
| 10. | <i>Ctenopharyngodon idella(Valenciennes)</i> | - |
| 11. | <i>Labeo angra(Hamilton)</i> | Ngaton |
| 12. | <i>Labeo bata (Hamilton)</i> | Ngaton |
| 13. | <i>Labeo calbasu (Hamilton)</i> | Ngathi |
| 14. | <i>Labeo roohita (Hamilton)</i> | Roou |
| 15. | <i>Osteobrama belangeri (Valenciennes)</i> | Pengba tharak |
| 16. | <i>Puntius chola</i> | Phabounga |
| 17. | <i>Puntius phutino (Hamilton)</i> | Ngakha meingangbi |
| 18. | <i>Puntius rana orphoides (Valenciennes)</i> | Ngakha |
| 19. | <i>Acanthophalus pangia (Hamilton)</i> | Nganap |
| 20. | <i>Lepidocephalus berdmorei (Blyth)</i> | Ngakichrou |
| 21. | <i>Mystus bleekeri (Day)</i> | Ngashep |
| 22. | <i>Mystus microphthalamus (Day)</i> | Ngara |

| | | |
|-----|--|------------------|
| 23. | <i>Clarias batrachus</i> (Linn) | Ngakra |
| 24. | <i>Heteropneustes fossilis</i> (Bloch) | Ngachik |
| 25. | <i>Channa marulius</i> (Hamilton) | Ngamuporom |
| 26. | <i>Channa orientalis</i> (Bloch &Schneider) | Meetei ngamu |
| 27. | <i>Channa punctatus</i> (Bloch) | Ngamu bogra |
| 28. | <i>Chanda baculis</i> (Hamilton) | Ngamhai |
| 29. | <i>Oreochromis mossambica</i> (Peters) | Tunghanbi |
| 30. | <i>Glossogobius giuris</i> (Hamilton) | Nailongnga |
| 31. | <i>Anabas testudineus</i> (Bloch) | Ukabi |
| 32. | <i>Colisa fasciatus</i> (Bloch) | Ngapemma |
| 33. | <i>Colisa sota</i> (Day) | Phetin |
| 34. | <i>Macrognathus armatus</i> (Lacepede) | Ngaril |
| 35. | <i>Puntius sarana sarana</i> (Hamilton) | Nganoi |
| 36. | <i>Osteobrama cotio cotio</i> (Hamilton) | Ngaseksha tharak |

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PR90

Appendix 3. List of Mammals recorded in Loktak Lake

(Source: Shamungou et al 2010)

| Sl.No. | Zoological Name | Common Name | Local Name |
|--------|-----------------------------|--------------------|------------|
| 1. | <i>Axis porcinus</i> | Hog Deer | Kharsa |
| 2. | <i>Rucervus eldii eldii</i> | Brow-antlered Deer | Sangai |
| 3. | <i>Golunda ellioti</i> | Indian Bush Rat | Uchi |
| 4. | <i>Sus scrofa</i> | Wild Pig | Lamok |

